Final Report

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The project “Measures for conservation and restoration of natural heritage in Bourgas and Enez (MoreCare) ”, CB005.1.12.115, is co-funded by the European Union through the Interreg-IPA CBC Bulgaria–Turkey Programme.

Summary of studies performed under the project:

1. **Lake Gala water quality studies**
    - Three sampling points were selected at Lake Gala, and samples were taken for a period of 12 months.
    - Physical, chemical, and bacteriological analyses were performed on the water samples taken.
    - Results obtained as a result of analyses were evaluated according to parameters as defined under Quality Criteria based on Classification of Intra-continental Surface Water Resources as stipulated under the Regulation on Management of Surface Water Quality.

2. **Trainings**
    - We attended a three-day training held in Burgas, Bulgaria on October 9-11, 2017. In the meeting, we made presentations on Lake Gala's water quality and bird habitat. An on-site visit was made to inspect Lake Vaya.
    - A meeting was held by specialists of project parties in order to determine methodologies for water measurements to be performed. A technical visit was made to the water analysis laboratory in Burgas.
    - We participated in the meeting held between on October 17-19, 2018 in Enez, Turkey. In the meeting, presentations were made on Lake Gala's water quality, soil characteristics of agricultural lands surrounding Lake Gala, socioeconomic structure of Province of Edirne, and bird population of Laka Gala. Water samples were taken from Lake Gala, and subjected to analysis according to parameters which could be measured at site. We also watched birds in the immediate vicinity of the Lake.

3. **Preparation of report**
    The final report is prepared according to results obtained.

Introduction

Meriç River rising from Rila Mountain (2925 m) in Bulgaria includes the three major tributaries such as Tunca, Arda and Ergene and begins to flow in a wide bed beginning from the North of İpsala. This wide bed, beginning from Meriç-Ergene junction point, is the starting point of Below Meriç Flood Plain. The flood plain scatters beginning from this point and it is turned by Hisarlıdağ volcanic mass in the South and lies rectangular. Gala, Pamuklu and Sığırcı lakes are in Meriç Delta Wetland and they are the outputs of the environment prepared by the alluvions stored by Meriç River. Meriç Delta Wetland and buffer zone in Enez and İpsala districts include total of 27.490 ha area.

Excess waters of Gala Lake are transferred to Enez lagoons via vents and channels constructed by General Directorate of State Hydraulic Works. Therefore, Big Gala Lake, Gala Pond, Pamuklu Lake, Sığırcı Lake (Yeni Karpuzlu Pond), Enez lagoons and Meriç River move as a whole wetland.

When the altitude of Meriç Delta is examined, it is seen that the areas under 35 m include the widest areas. Hisarlı Mountain constitutes the highest zone of Meriç Delta. This mass is formed of volcanic rocks and it is elliptical. Hisarlı Mountain is in the southwest of Gala Lake with some hills over 430 m locally.

Lake Gala is located in a region in Edirne province borders where the river Maritsa meets the Aegean Sea. The lake is 2 meters above sea level and is 10 km far to Enez and Aegean Sea. It is an alluvial set lake lying at 40°46'06.79'' N and 26°11'07.63'' E and is connected to Maritza River and Saros bay with lake. The depth of the lake varies according to meteorological conditions and to the amount of water used for rice field irrigation. The deepest part of the lake is 2.2 meters during rainy season with increased flood, 1.5 meters during normal conditions and can decrease to 30-40 cm. in dry seasons. During summer, the lake is separated into two sections, Big and Small Gala Lakes, due to drying.

The bank of the lake is accompanied by macrovegetation consisting of *Phragmites australis* and *Typha* sp. The lake is surrounded with a lot of agricultural areas where rice plantation is carried out mostly

Gala Lake National Park covers an area of 6.090 ha, of which 3.090 is wetland and 3.000 ha is forest area. In addition, Gala Lake is a part of Maritza Delta listed in class a wetlands and lies along northwest-south axis constituting one of the two main bird migration routes in western Palaearctic region. A total of 163 avian species exist in national park borders of which 46 are native, 27 are winter migrants and 90 are summer migrants. The fish fauna of the region is represented with 16 species among them eel, lucioperca and pike are the prominent taxa of major economic importance.

Gala Lake has a habitat diversity due to the closeness to the sea, forest ecosystem near abroad, meadow areas and highlands. Besides its fresh water and watery environment. As National Park is on North-South bird migration road route passing over Turkey, it is quite appropriate for the activities such as bird observation, habitat observation and nature photography.

Gala and Pamuklu Lakes was given Nature Reserve Area status in 1991 and in 1992, the area around Gala Lake was announced as Natural Protected Area. The region where Gala and Pamuklu Lakes are located was announced as the 36th National Park of Turkey in 2005.

Findings and Discussions

1. ***Results of water quality studies performed on Lake Gala***

Under the project, samples were taken from three different sampling points in order to determine the water quality of Lake Gala. Samples were taken on a monthly basis for a period of 12 months in total.
Water samples taken were subject to following physical, chemical, and biological analyses:

- Total dissolved solids (TDS)
- Oxidation-reduction potential (ORP)

- Dissolved oxygen (DO)
- Turbidity (NTU)
- Chlorophyll
- BGA-PC (green algae)
- Biological Oxygen Demand (BOD)
- Chemical Oxygen Demand (COD)
- Ammonium nitrogen(NH_4-N)
- Nitrate nitrogen (NO_3-N)
- Nitrite nitrogen (NO_2-N)
- Phosphor (P)
- pH
- Electrical Conductivity (EC)
- Suspended solids (SS)
- Oil and grease
- Faecal coliform
- Trace elements and inorganic parameters (Mn, Fe, Zn, Cu, Cr, Co, Pb, Ni, Cd)
- Anions and cations (CO_3^{-2}, HCO_3^-, Cl^-, Na^+, K^+, Ca^{+2}, Mg^{+2})

Sampling points were specifically selected as representative points for Lake's water quality. Such sampling points are as shown in Figure 1.

Results of analyses were evaluated according to parameters as defined under Quality Criteria based on Classification of Intra-continental Surface Water Resources as stipulated under the Regulation on Management of Surface Water Quality (Table 1).

Figure1. Lake Gala Sampling Point

Table 1. Quality Criteria based on Classification of Intra-continent Surface Water Resources (QCCISWR)

Water Quality Parameters	Water Quality Classification [a]			
	I	II	III	IV
General Requirements				
Temperature (^{o}C)	≤ 25	≤ 25	≤ 30	> 30
Colour (m^{-1})	RES 436 nm: ≤ 1,5 RES 525 nm: ≤ 1,2 RES 620 nm: ≤ 0,8	RES 436 nm: 3 RES 525 nm: 2,4 RES 620 nm: 1,7	RES 436 nm: 4,3 RES 525 nm: 3,7 RES 620 nm: 2,5	RES 436 nm: >4,3 RES 525 nm: >3,7 RES 620 nm: >2,5
pH	6,5-8,5	6,5-8,5	6,0-9,0	< 6,0 or > 9,0
Conductivity (µS/cm)	< 400	1000	3000	> 3000
Oil and Grease	No floating liquids such as oil and tar, nor solids such as garbage and alike, nor foam.			-
(A) Oxygenation Parameters				
Oxygen Saturation (%) [b]	>90	70	40	< 40
Dissolved Oxygen (mg O_2/L) [b]	> 8	6	3	< 3
Chemical Oxygen Demand (COD) (mg/L)	< 25	50	70	> 70
Biochemical Oxygen Demand (BOD_5) (mg/L)	< 4	8	20	> 20
B) Nutrient Parameters				
Ammonium Nitrogen (mg NH_4^+-	< 0,2	1	2	> 2

N/L) [c]				
Nitrate Nitrogen (mg NO_3^--N/L)	< 5	10	20	> 20
Nitrite Nitrogen (mg NO_2^--N/L)	< 0,01	0,06	0,12	> 0,3
Total Kjeldahl Nitrogen (mg N/L)	< 0,5	1,5	5	> 5
Total Phosphor (mg P/L)	< 0,03	0,16	0,65	> 0,65
C) Trace Elements (Metals) and Inorganic Contamination Parameters [d]				
Aluminium (mg Al/L)	≤ 0,3	≤ 0,3	1	> 1
Arsenic (µg As/L)	≤ 20	50	100	> 100
Copper (µg Cu/L)	≤ 20	50	200	> 200
Barium (µg Ba/L)	≤ 1000	2000	2000	> 2000
Boron (µg B/L)	≤ 1000	≤ 1000	≤ 1000	> 1000
Mercury (µg Hg/L)	≤ 0,1	0,5	2	> 2
Zinc (µg Zn/L)	≤ 200	500	2000	> 2000
Iron (µg Fe/L)	≤ 300	1000	5000	> 5000
Fluoride (µg F^-/L)	≤ 1000	1500	2000	> 2000
Cadmium (µg Cd/L)	≤ 2	5	7	> 7
Cobalt (µg Co/L)	≤ 10	20	200	> 200
Chromium (µg Cr+6/L)	Too small to be measured	20	50	> 50
Chromium (total) (µg Cr/L)	≤ 20	50	200	> 200
Lead (µg Pb/L)	≤ 10	20	50	> 50
Manganese (µg Mn/L)	≤ 100	500	3000	> 3000
Nickel (µg Ni/L)	≤ 20	50	200	> 200
Selenium (µg Se/L)	≤ 10	≤ 10	20	> 20
Free chlorine (µg Cl2/L)	≤ 10	≤ 10	50	> 50
Cyanide (total) (µg CN/L)	≤ 10	50	100	> 100
Sulphur (µg S=/L)	≤ 2	≤ 2	10	> 10
Hazardous Materials	Hazardous materials and other contaminants not listed in this Table will be assessed starting from 1 January 2016 after establishing country inventory (reference values) for them.			
D) Bacteriological Parameters				
Faecal Coliform (Membran)	≤10	200	2000	> 2000
Total Coliform (Membran)	≤100	20000	100000	> 100000

(a) Intended use of waters according to quality classification:

Class I – High quality water (All parameters meeting Class I water quality waters show "Very Good" water quality):

1) Surface waters with a high potential of being used as drinking water,
2) Water which can be used for recreational purposes, including swimming which require contact with body,
3) Water quality suitable for being used for trout farming,
4) Water quality suitable for being used for animal breeding and farm needs.

Class II – Slightly contaminated water (Values between Class I and Class II water qualities show "Good" water quality):

1) Surface waters with a potential for being used as drinking water,
2) Water which can be used for recreational purposes
3) Water which can be used for farming of fishes except for trout,
4) Irrigation water provided that irrigation water criteria as defined under the applicable legislation are met,

Class III – Contaminated water (Values between Class II and Class III water qualities show "Average" water quality):
Water quality suitable for being used for aquaculture or industrial water after suitable treatment, except for facilities which require use of qualified water such as food, textile facilities,

Class VI – Very contaminated water (Values between Class III and Class IV water qualities show "Poor" water quality):
Surface waters which have inferior quality compared to Class III waters, and which can meet parameters of an upper class only after being improved as required.

(b) It is enough to meet either concentration parameter or saturation percentage parameter.

(c) Free ammonia nitrogen concentration should not be greater than 0,02 mg NH_3^-N/L depending on the pH value.

(d) Criteria relating to that group indicate total concentration of chemical species which constitute parameters.

Analysis results of water samples taken from sampling point 1 are as shown in Table 2. According to analysis results listed in the table, in terms of water quality in the sampling point, there is no concern with respect to pH value, and water's EC values vary between 0,509 and 2,13 dS/m. EC values are in January, February, March, and April 2018 are lower

compared to other months, and meet criteria for good water quality. On sampling dates other than the foregoing months, water samples taken from sampling point 1 are classified as Average (Class III) in terms of salinity (1,19 and 2,13 dS/m). When evaluated as per seasons, Lake's salinity decreases during winter months, and increases during summer months. Such decrease in winter months can be attributed to increasing water quantity in the Lake resulting from increased precipitation during winter months while such increase in summer months can be attributed to decreasing water quantity in the Lake as a result of evaporation during summer months.

Oxidation parameters, i.e. BOD and COD, were only measured in July 2017, and Lake's water was classified as very contaminated in terms of BOD, and slightly contaminated in terms of COD.

In terms of nutrients parameter, NH_4^+-N was measured to be between 5,18 and 9,24 mg/l, and accordingly Lake's water is classified as very contaminated in terms of that parameter. There is no concern with respect to NO_3^--N, and no NO_2^--N has been detected. Phosphor values vary between 19,22 and 195,23 µg/l which indicates a good water quality. High NH_4^+-N values may result from intensive use of urea and ammonium in the paddy fields around the Lake used to grow rice, which flows into the Lake water through underground and surface waters after being discharged from the paddy fields.

In evaluation of the Lake water in terms of bacteriological parameters (faecal coliform), the Lake water is classified in different contamination levels (II-III-IV) in different months independent of the seasonal conditions.

In terms of trace elements (metals) and Inorganic Contamination Parameters, no matter of concern was observed with the Lake water for Mn, Zn, Cu, Cr Co, Ni, and Cd while Fe was determined to be high in December 2017 and February 2018. Pb values were determined to be high in December 2017, January 2018, and February 2018 while classified as very good quality water for other months.

<u>Samples taken from second sampling point of Lake Gala (Table 3):</u>

Though salinity level is not very high, the water quality is classified as very good quality (I) for one month, good quality for four months (0,464 and 0,952 dS m^{-1}), and average quality for six months (1,473 and 2,582 dS m^{-1}).

Lake water is generally classified under Class III in terms of bacteriological contamination.

Water sample taken from the second sampling point was determined to have good and average quality in terms of BOD values while determined to have good quality in terms of COD values.

Of nutrients, only ammonium values increased in some months, and the water quality was classified as poor-very contaminated water.

Phosphorus values were classified as Second II, i.e. very good quality, except for July 2018.

Of trace elements (Metals) and Inorganic Contamination Parameters, only Fe (January 2018 and March 2018) and Pb (November 2017, January-February-March 2018) values were determined to be at level of concern only in some months.

Water samples taken from third sampling point (Table 4):

Water's salinity was determined to be between 0,531 and 2,708 dS m^{-1} (Class II and III),

Faecal coliform values were determined to be between 20 and 22600 CFU/100 ml (Classes II-III-IV),

BOD values were determined to be between 5 and 20 mg L^{-1} (Class II and III), COD values were determined to be between 11,6 and 49,87 mg L^{-1} (Class I and II).

Regarding nutrients, just like the other two sampling points, only NH-N values were determined to be high (Class IV) while NO3-N ve NO2-N caused no contamination.

Phosphor values were classified as good and average; Mn values were classified as good; Fe values were classified under Class II in November 2017 while determined to have average contamination according to the water sample taken in January 2018; while for the rest of the months, it was classified as high quality water.

No Zn, Cu, Cr, Co, Ni, and Cd were found, and Pb values were classified under Class IV in December 2017 and January 2018.

Table 2. Results of Analysis for Sampling Point 1 in Lake Gala

Sampling Date	pH	EC (dS/m)	CO_3^{-2} (me/l)	HCO_3^{-} (me/l)	Cl^{-} (me/l)	Na^{+} (me/l)	Mg^{+2} (me/l)	K^{+} (me/l)	Ca^{+2} (me/l)	SAR	Hardness (German)	SS mg/L	Oil and Grease mg/L	Faecal Coliform (CFU/100 ml)
July 2017	8,49	1,899	0,5	2,95	13,82	13,75	4,29	0,27	2,01	7,74	17,65	-	-	135
November 2017	8,28	2,119	0,7	5,45	14,35	14,82	5,58	0,21	4,08	6,74	27,05	-	-	400
December 2017	8,36	2,135	0,79	4,71	11,28	14,71	5,76	0,38	4,92	6,36	29,92	-	-	180
January 2018	7,97	0,821	-	3,68	4,42	4,66	2,53	0,13	2,77	2,86	14,88	-	-	8000
February 2018	7,98	0,509	-	2,66	1,73	1,95	1,76	0,12	2,22	1,38	11,17	0,048	-	800
March 2018	8,22	0,610	0,59	3,38	2,74	2,86	2,04	0,14	2,80	1,84	13,59	-	-	10
April 2018	8,10	0,751	0,43	3,94	2,83	2,96	2,21	0,13	2,86	1,86	14,21	-	-	5500
May 2018	8,17	1,196	1,13	4,70	6,14	8,11	4,28	0,32	3,58	4,09	22,02	-	-	970
June 2018	7,80	1,813	-	4,46	11,33	11,86	4,72	0,26	4,23	5,61	25,07	0,076	-	22000
July 2018	8,36	1,718	0,77	4,03	13,76	13,88	4,79	0,26	2,57	7,24	20,62	0,024	-	100
August 2018	8,30	1,830	0,42	4,89	11,90	10,95	4,01	0,18	2,42	6,10	18,02	0,048	-	270
September 2018	7,90	1,913	-	6,8	12,58	11,86	4,73	0,17	3,96	5,69	24,33	0,024	-	2500

	Class I		Class I		Class III		Class IV

QCCISWR- Quality Criteria based on Classification of Intra-continent Surface Water Resources

Table 2 cont'd

Sampling Date	BOD mg/l	COD mg/l	NH_4 mg/l	NO_3 (mg/l)	NO_2 (mg/l)	P (µg/l)	Mn (µg/l)	Fe (µg/l)	Zn (µg/l)	Cu (µg/l)	Cr (µg/l)	Co (µg/l)	Pb (µg/l)	Ni (µg/l)	Cd (µg/l)
July 2017	50	64,9	-	0,06	-	19,22	-	13,33	-	-	-	-	0,83	-	-
November 2017	-	-	-	-	-	90,07	-	99,03	-	-	-	-	14,5	1,7	-
December 2017	-	-	5,5	0,54	-	159,3	155,01	2313,5	-	-	-	-	330,7	7,7	-
January 2018	-	-	-	0,34	-	79,18	17,06	332,5	9,61	-	-	-	55,86	0,8	-
February 2018	-	-	-	0,51	-	83,21	23,19	659,0	7,4	-	-	-	123,7	2,1	-
March 2018	-	-	-	0,29	-	37,42	4,47	41,9	-	-	-	-	5,84	0,2	-
April 2018	-	-	5,18	-	-	91,01	7,98	20,8	-	-	-	-	4,50	0,3	-
May 2018	-	-	7,71	-	-	65,35	114,04	-	-	-	-	-	0,00	-	-
June 2018	-	-	7,85	0,45	-	148,7	19,57	67,5	38,2	-	-	-	16,69	2,1	-
July 2018	-	-	9,24	-	-	133,39	81,33	-	-	-	-	-	0,00	0,4	-
August 2018	-	-	5,45	-	-	195,23	2,46	2,08	-	-	-	-	2,20	0,2	-
September 2018	-	-	7,71	-	-	63,10	-	9,48	-	-	-	-	3,12	-	-

	Class I		Class II		Class III		Class IV

QCCISWR- Quality Criteria based on Classification of Intra-continent Surface Water Resources

Table 2 cont'd

Sampling Date	TDS (mg/l)	ORP	DO % Sat.	DO (mg/l)	Turbidity (NTU)	Chlorophyll (µg/l)	BGA-PC (Cells/mL)
March 2018	447	142,6	128,3	12,96	0	0	5173
April 2018	527	138,5	118,1	11,08	40,9	0	30353
May 2018	923	181,6	141,4	11,7	0	67,69	12153
June 2018	1420	158	104,5	8,53	7,8	0	30860
July 2018	1311	89,3	135,6	9,82	1,6	5,47	23473
August 2018	1391	34,1	113,1	9,2	2,6	0	32909
September 2018	1563	143,2	110	9,18	2,3	0	16319

Table 3. Results of Analysis for Sampling Point 2 in Lake Gala

Sampling Date	pH	EC (dS/m)	CO_3^{-2} (me/l)	HCO_3^{-} (me/l)	Cl^{-} (me/l)	Na^{+} (me/l)	Mg^{+2} (me/l)	K^{+} (me/l)	Ca^{+2} (me/l)	SAR	Hardness (German)	SS mg/L	Oil and Grease mg/L	Faecal Coliform (CFU/100 ml)
July 2017	7,87	2,582	-	5,1	20,35	18,53	6,96	0,37	3,41	8,13	29,07	-	-	220
November 2017	8,11	2,223	0,76	5,54	14,64	14,75	6,53	0,27	3,9	6,46	29,23	-	-	575
January 2018	7,7	0,489	0	2,65	2,59	1,89	1,59	0,09	1,94	1,43	9,91	-	-	1100
February 2018	8,39	0,464	0,72	2,64	1,49	1,77	1,59	0,12	1,96	1,33	9,95	-	-	640
March 2018	7,11	0,185	-	1,02	1,01	0,86	0,44	0,09	0,90	1,05	3,78	-	-	300
April 2018	8,02	0,682	0,43	4,05	1,78	2,43	2,52	0,13	2,82	1,49	14,96	-	-	5200
May 2018	9,01	0,952	2,06	4,08	4,08	6,47	3,80	0,17	1,94	3,83	16,09	-	-	400
June 2018	9,00	1,473	2,45	4,66	9,20	11,17	5,03	0,10	1,61	6,13	18,59	-	-	1000
July 2018	8,92	2,200	1,66	4,89	13,58	17,10	6,73	0,28	2,86	7,81	26,83	-	-	200
August 2018	9,31	2,073	2,80	4,80	11,71	12,56	5,30	0,22	1,52	6,80	19,11	-	-	450
September 2018	8,93	1,935	2,13	5,94	12,20	12,59	5,50	0,23	1,96	6,51	21,00	-	-	1300

*No sample taken in December 2017 due to adverse weather conditions (frost).

	Class I		Class II		Class III		Class IV

QCCISWR- Quality Criteria based on Classification of Intra-continent Surface Water Resources

Table 3 cont'd

Sampling Date	BOD mg/L	COD mg/L	NH_4 mg/l	NO_3 (mg/l)	NO_2 (mg/l)	P (µg/l)	Mn (µg/l)	Fe (µg/l)	Zn (µg/l)	Cu (µg/l)	Cr (µg/l)	Co (µg/l)	Pb (µg/l)	Ni (µg/l)	Cd (µg/l)
July 2017	20	63,98	-	-	-	180,1	-	14,6	-	-	-	-	2,59	-	-
November 2017	-	-	-	-	-	87,0	110,33	728,8	0,28	-	-	-	101,9	4,68	-
January 2018	-	-	-	0,8	-	57,3	34,21	1818,1	-	-	-	-	313,0	11,16	-
February 2018	10	48,01	-	0,38	-	22,9	26,36	1371,1	-	-	-	-	191,4	1,92	-
March 2018	-	-	-	0,15	-	46,1	18,84	568,5	-	-	-	-	85,4	-	-
April 2018	5	6,63	4,72	-	-	110,9	2,6	32,02	-	-	-	-	6,41	1,17	-
May 2018	15	19,1	4,69	-	-	124,0	-	4,95	-	-	-	-	1,36	-	-
June 2018	-	-	-	-	-	108,6	21,3	149,0	2,51	-	-	-	33,6	1,41	-
July 2018	5	20,4	10,26	-	-	153,8	11,27	5,50	-	-	-	-	1,87	1,63	-
August 2018	10	32,3	10,06	-	-	54,1	8,29	3,0	-	-	-	-	2,28	1,73	-
September 2018	5	15,2	9,8	-	-	62,5	-	9,4	-	-	-	-	2,94	-	-

	Class I		Class II		Class III		Class IV

QCCISWR- Quality Criteria based on Classification of Intra-continent Surface Water Resources

Table 3 cont'd

Sampling Date	TDS (mg/l)	ORP	DO % Sat.	DO (mg/l)	Turbidity (NTU)	Chlorophyll (µg/l)	BGA-PC (Cells/mL)
March 2018	185	150,5	113,8	11,83	5,9	-	26889
April 2018	495	119,3	117,2	11,0	22,3	0,42	27925
May 2018	668	117,9	120,3	9,84	10,2	-	22125
June 2018	1279	66,9	138,5	11,2	-	-	-
July 2018	1570	64,2	204,1	15,56	0,2	-	15959
August 2018	1534	33,7	134,7	10,68	-	-	38140
September 2018	1488	70,4	183,7	14,69	3,3	16,23	28034

Table 4. Results of Analysis for Sampling Point 3 in Lake Gala

Sampling Date	pH	EC (dS/m)	CO_3^{-2} (me/l)	HCO_3^- (me/l)	Cl^- (me/l)	Na^+ (me/l)	Mg^{+2} (me/l)	K^+ (me/l)	Ca^{+2} (me/l)	SAR	Hardness (German)	SS mg/L	Oil and grease mg/L	Faecal coliform (CFU/100 ml)
July 2017	7,53	2,708	-	5,07	17,95	16,81	6,68	0,25	4,66	7,06	31,78	-	-	120
November 2017	7,9	2,207	-	5,49	14,16	14,19	6,29	0,21	4,26	6,18	29,57	-	-	450
December 2017	7,88	1,735	-	4,19	8,69	10,81	5,51	0,33	4,25	4,89	27,33	-	-	1250
January 2018	7,91	0,531	-	2,52	2,06	2,36	1,81	0,10	1,92	1,73	10,47	-	-	3600
February 2018	8,1	0,598	0,58	3,09	2,02	2,3	2,39	0,12	2,54	1,47	13,83	-	-	50
March 2018	7,61	0,698	-	3,29	3,12	3,49	2,21	0,18	2,94	2,17	14,46	-	-	20
April 2018	7,97	0,781	-	4,70	2,26	2,71	3,24	0,13	3,28	1,50	18,27	-	-	8200
May 2018	7,67	0,928	-	4,97	3,60	5,87	4,89	0,11	2,91	2,97	21,85	-	-	300
June 2018	7,51	1,887	-	5,56	12,0	12,71	5,65	0,22	4,25	5,71	27,72	-	-	22600
July 2018	7,59	1,802	-	5,57	10,32	12,79	6,04	0,17	3,60	5,82	27,01	-	-	150
August 2018	7,63	1,681	-	6,79	9,89	9,60	4,73	0,19	3,67	4,69	23,53	-	-	780
September 2018	7,72	1,751	-	7,25	10,31	10,01	4,92	0,13	3,78	4,80	24,39	-	-	1900

	Class I		Class II		Class III		Class IV

QCCISWR- Quality Criteria based on Classification of Intra-continent Surface Water Resources

Table 4 cont'd

Sampling Date	BOD mg/L	COD mg/L	NH_4 mg/l	NO_3 (mg/l)	NO_2 (mg/l)	P (µg/l)	Mn (µg/l)	Fe (µg/l)	Zn (µg/l)	Cu (µg/l)	Cr (µg/l)	Co (µg/l)	Pb (µg/l)	Ni (µg/l)	Cd (µg/l)
July 2017	20	49,87	4,02	-	-	54,58	-	12,5	-		-	-	0,36	-	-
November 2017	-	-	23,29	-	-	65,45	202,02	310,61	-		-	-	43,36	-	-
December 2017	10	29,2	10,36	0,83	-	221,54	100,09	411,6	-		-	-	57,90	-	-
January 2018	10	30,5	-	0,97	-	51,23	54,22	1671,6	-		-	-	301,42	-	-
February 2018	10	34,75	-	3,45	-	9,28	4,55	214,64	-		-	-	35,41	-	-
March 2018	-	-	-	0,05	-	195,87	469,76	67,91	-		-	-	10,98	-	-
April 2018	5	18,12	4,48	0,02	-	129,14	202,38	34,95	-		-	-	6,93	-	-
May 2018	5	11,6	2,72	-	-	119,12	-	-	-		-	-	0,00	-	-
June 2018	-	-	1,0	-	-	139,09	93,0	17,80	29,1		-	-	4,38	-	-
July 2018	5	17,6	6,00	-	-	18,26	-	-	-		-	-	0,00	-	-
August 2018	10	25,2	5,54	2,01	-	23,11	2,64	-	0,43		-	-	1,44	-	-
September 2018	5	16,7	5,99	-	-	15,65	38,00	-	-		-	-	0,81	-	-

	Class I		Class II		Class III		Class IV

QCCISWR- Quality Criteria based on Classification of Intra-continent Surface Water Resources

Table 4 cont'd

Sampling Date	TDS (mg/l)	ORP	DO % Sat.	DO (mg/l)	Turbidity (NTU)	Chlorophyll (µg/l)	BGA-PC (Cells/mL)
March 2018	601	152,8	99,6	9,99	601	-	1249
April 2018	599	122,1	107,6	9,97	-	-	1956
May 2018	696	126,1	90,4	7,59	3,6	-	11126
June 2018	1543	84	85,7	6,93	2,4	-	-
July 2018	1402	63,6	90,9	7,13	-	-	14901
August 2018	1248	113	80,8	6,72	171	-	16182
September 2018	1361	55,3	74	6,13	-	-	6457

Some parameters of water samples taken from three different sampling points in Lake Gala were analyzed seasonally, and are shown in the graphics below.

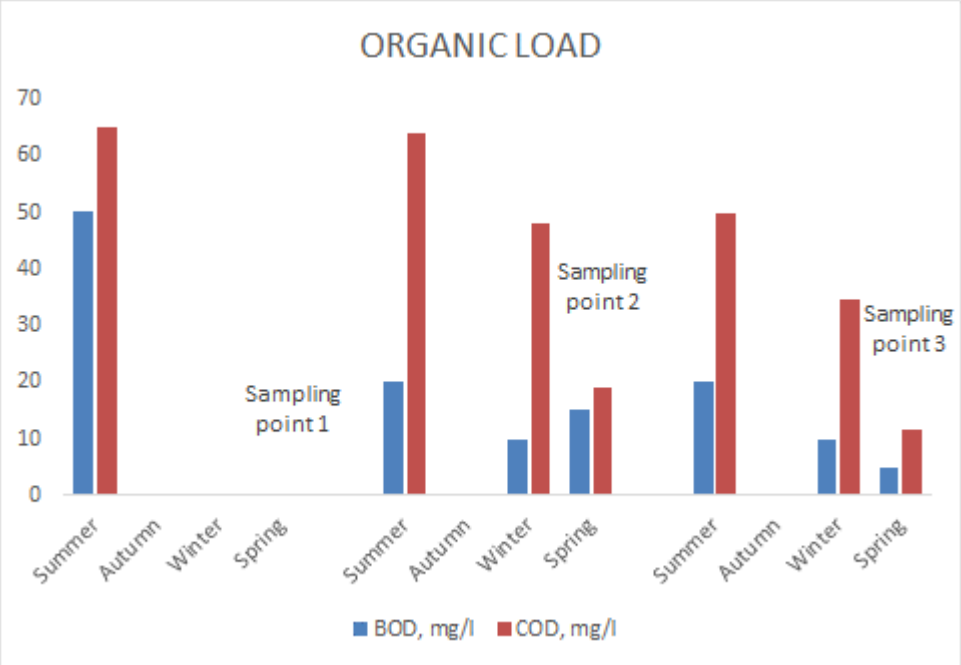

Figure 2. Seasonal graphic of BOD and COD parameters

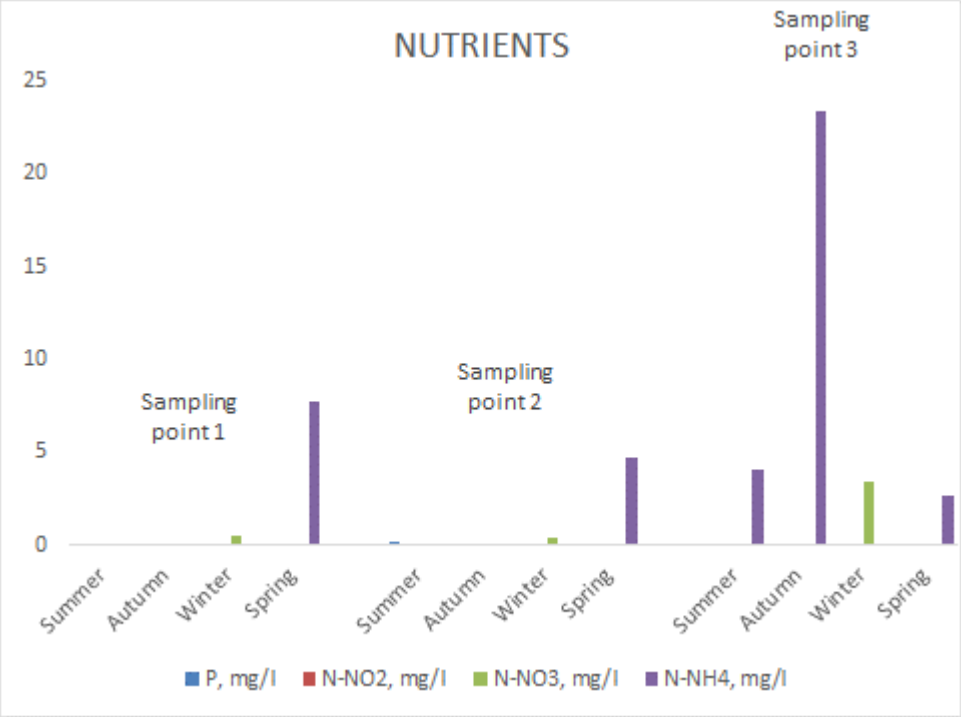

Figure 3. Seasonal graphic of P, HN4-N, NO3-N, and NO2-N parameters

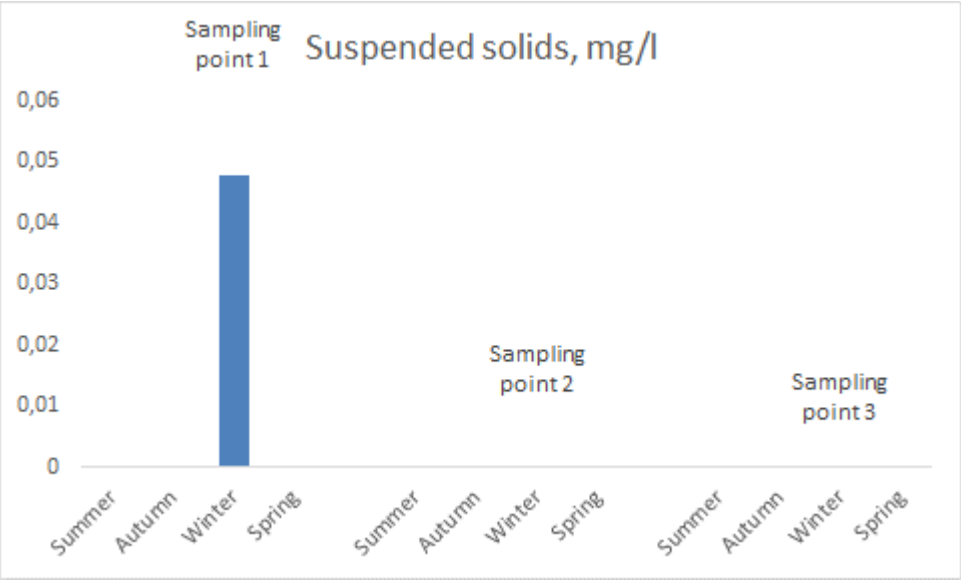

Figure 4. Seasonal graphic of suspended solids (SS)

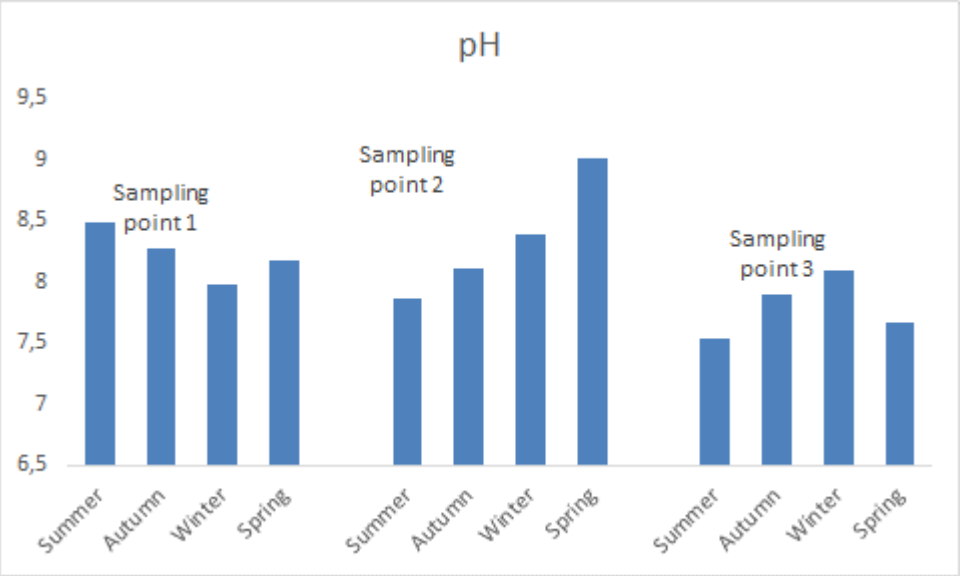

Figure 5. Seasonal graphic of pH values

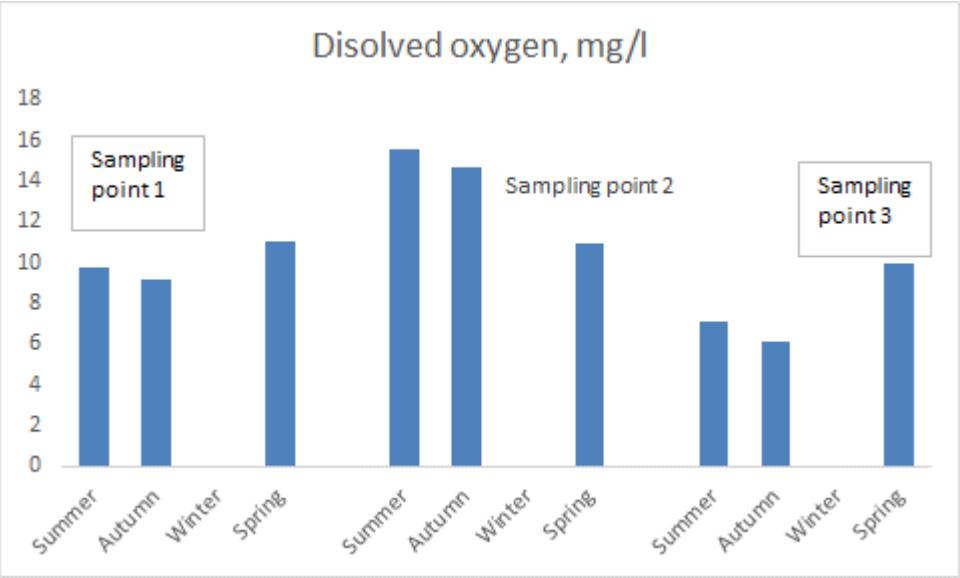

Figure 6. Seasonal graphic of dissolved oxygen values

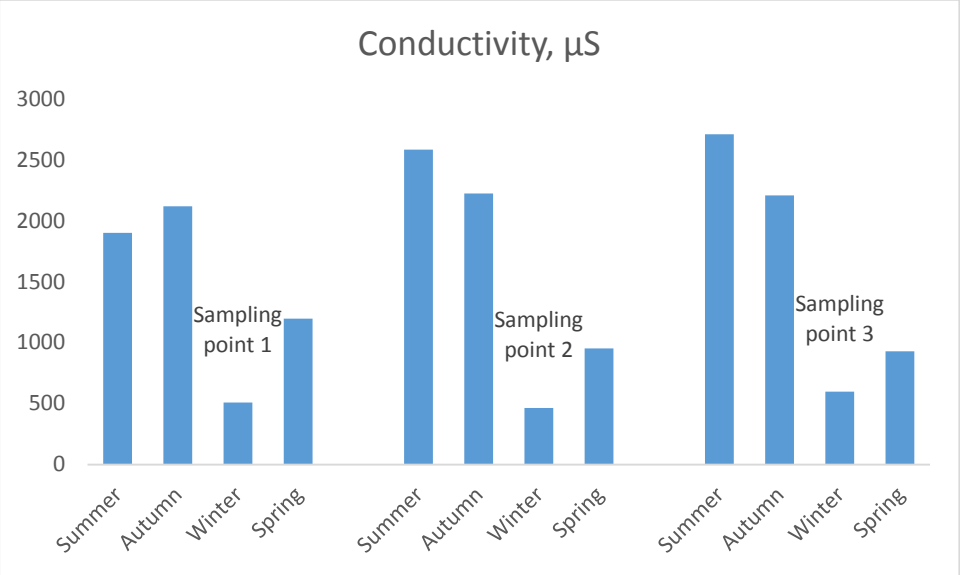

Figure 7. Seasonal graphic of electrical conductivity

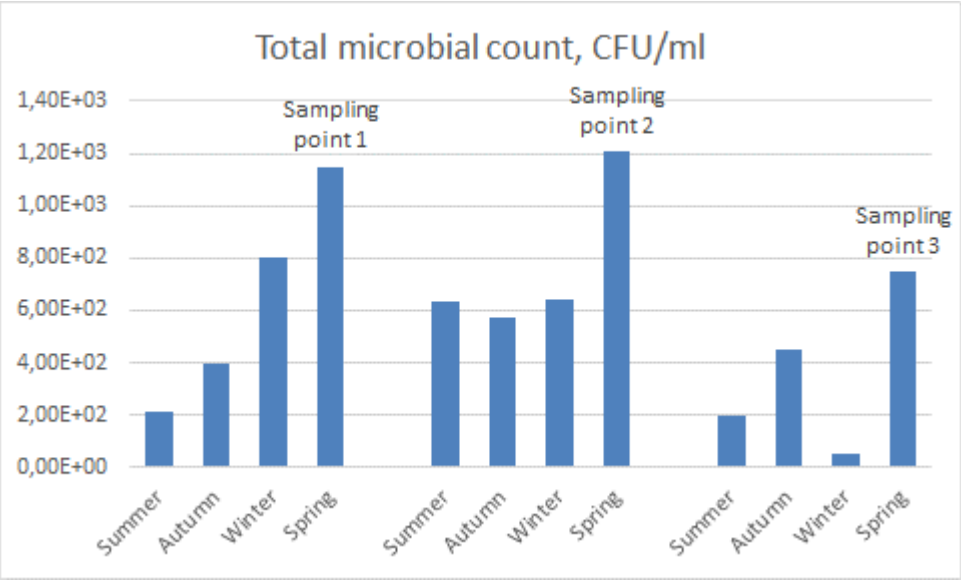

Figure 8. Seasonal graphic of faecal coliform values

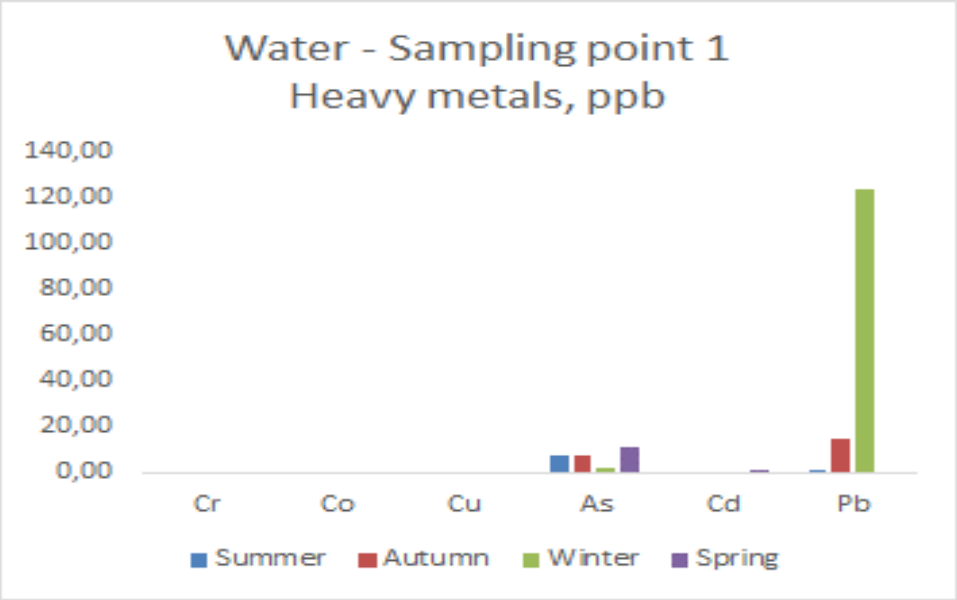

Figure 9. Seasonal graphic of heavy metal values of water samples taken from first sampling point

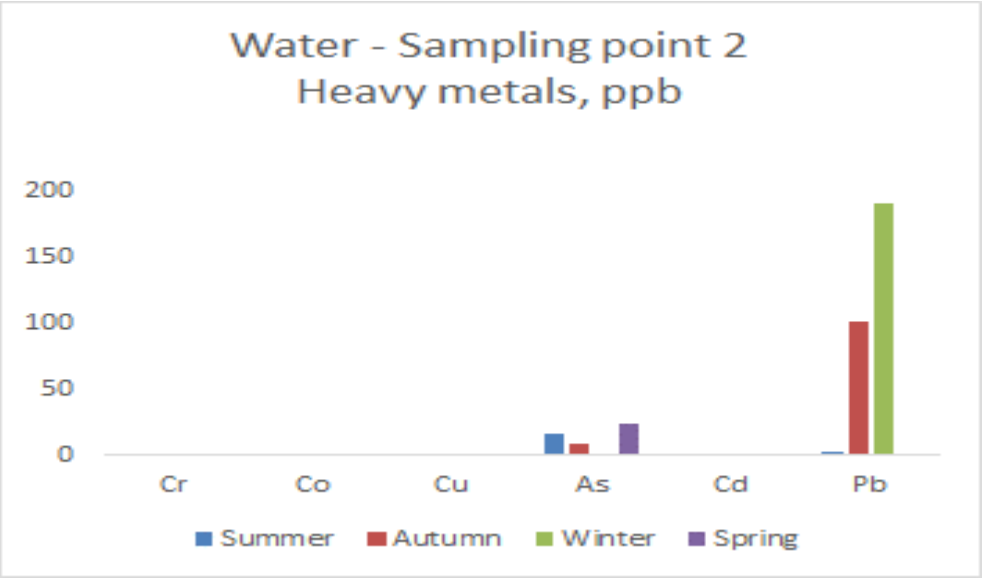

Figure 10. Seasonal graphic of heavy metal values of water samples taken from second sampling point

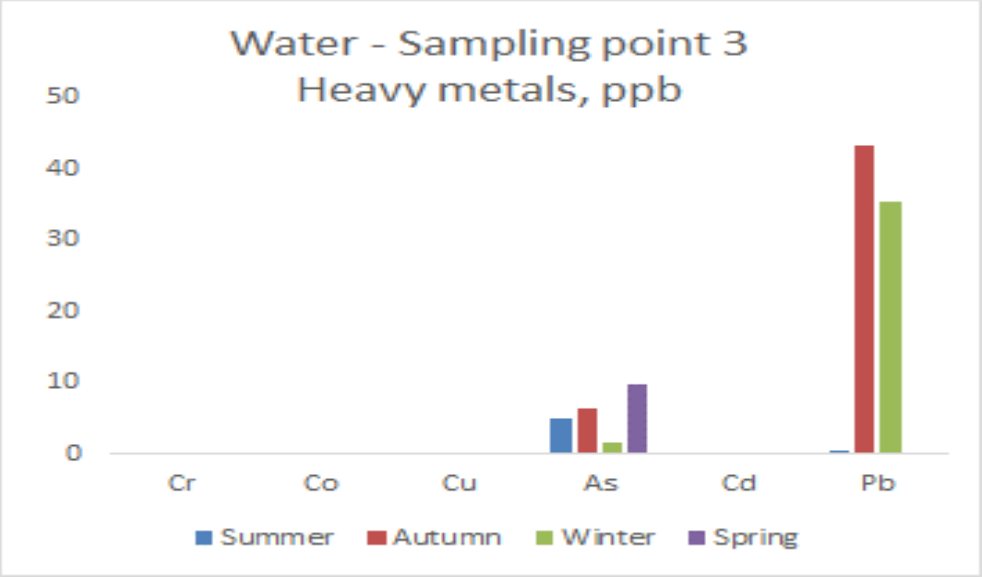

Figure 11. Seasonal graphic of heavy metal values of water samples taken from third sampling point

Evaluation of Lake Gala in terms of water quality:

- Results of analyses on samples from all three sampling points are similar.
- Salinity values vary between 0,185 and 2,708, with an increase observed in salinity during summer months.
- Oxidation parameters are not at a level of concern.
- Regarding nutrients, it is determined that there is only concern with respect to NH-H.

- Lake water is determined to have faecal coliform contamination. As samples were taken from Lake' shore, intense human and animal activities caused increase in values in some months.
- In some months, Mn, Fe, and Pb contamination was determined.
- No Zn, Cu, Cr, Co, Ni, and Cd contamination was determined.

Conclusions

1. **General overview**

Lake Gala National Park, located in Counties of Enez and Ipsala in Province of Edirne, and designated as Turkey's 36th National Park under the Council of Ministers' Decision as published in the Official Journal dated 05.03.2005, spans on an area of 6.090 hectares, of which 3.090 hectares are wetlands (Big Gala Lake, Small Gala Lake, Pamuklu Lake) and 3.000 hectares are forestlands (skirts of Mount Hisarlı).

Lake Gala National Park is located within the Meriç Delta Wetland which is listed in the List of Important Natural Areas, Important Bird Areas, and Important Plant Areas of Turkey, and designated as Class A international wetland meeting three Ramsar Criteria (Criteria 4, 5, and 6); and it has been evaluated under 2 main parts, i.e. Terrestrial Ecosystem and Aquatic Ecosystem.

Image 1. Dalmatian Pelican in Lake Gala natural habitat

Lake Gale National Park is located 8km to the County of Enez, 23 km to the County of İpsala, 50 km to the County of Keşan, 155 km to centre of Province of Edirne, and 240 km to Istanbul.

Lake Gala National Park is located in, and one of the largest wetlands of, Lower Meriç Flood Plain, bordering on Ergene Dry Forest–Anthropogenic Steppe Section of Marmara Transition Region and Aegean Subsection (Turkish Pine) of Mediterranean Climatic Area, i.e. the ecological regions of Turkey.

Main resource values of Lake Gala National Park include 3 lakes (Big Gala Lake, Small Gala Lake, Pamuklu Lake), and waterfowls living in reeds there. Among other resource values of the National Park are Mount Hisarlı and its skirts which feature endemic plants. In Mount Hisar, there is a Montpellier Maple Genetic Preservation Forest extending over an area of 60,3 hectares. Genetic preservation forests are strict preservation areas in which any type of intervention is strictly prohibited.

The region where the National Park represents various ecosystems as it is located in a transitional region featuring a wide range of ecosystems, including Mediterranean Shore ecosystems and terrestrial ecosystems.

311 plant species were identified in the Natural Park. 5 of them (*Dianthus ingoldbyi*, *Taraxacum aznavourii*, *Centaurea polyclada*, *Dianthus lydus* ve *Campanula lyrata subsp. lyrata*.) are endemic species.

59 *taxons* which can be used for medical and economic purposes have been identified in the Lake Gala National Park. 22 of such plants can be used for medical purposes while 13 of them can be used as ornamental plants. Species *Acer campestre, Pistacia terebinthus, Hedera helix, Xeranthemum annuum, Cornus mas, Quercus cerris, Quercus coccifera, Ficus carica, Rosa canina ve Typha angustifolia* are today actively used for economic purposes.

Image 2. A view of Lake Gala Reeds

165 bird species are seen in the National Park, of which 165 are domestic birds, 27 are winter migrant birds, and 90 are summer migrant birds. 16 fish species have been identified, including eel, pikeperch, carp, and northern pike which have high economic value.

Among bird species identified within boundaries of Lake Gala National Park are some rare and endangered species. Species such as White-headed duck (Oxyura leucocephala), White-tailed eagle (Haliaeetus albicilla), Osprey (Pandion haliaetus), Dalmatian Pelican (Pelecanus crispus), Pygmy Cormorant (Phalacrocorax pygmeus) are globally endangered species which are under protection while some other species which include in particular Swans (Cygnus spp.) and Pelicans (Pelecanus spp.) are under risk in the area due to risk they are exposed to in the area. Main threats to such species include killing of pelicans due to their excessive fish consumption, and smuggling of Swans due to high demand for Swans as ornamental animals. Other endangered species in the area include Glossy Ibis (Plegadis falcinellus), Spur-winged Lapwing (Vanellus spinosus), Purple Heron (Ardea purpurea), Black Stork (Ciconia nigra), Ruddy Shelduck (Tadorna ferruginea), Common Shelduck (Tadorna tadorna), and Common Kingfisher (Alcedo atthis).

There are 9 Amphibia (Amphibian) species, 25 Reptilia (Reptilian) species, 1 *Erinaceomorpha* (Hedgehog) specie, 6 *Soricomorph* (*insectivore*) species, 24 *Chiroptera* (*Bat*) species, 1

Lagomorpha (*Rabbit*) specie, 17 *RODENTIA* (*Rodent*) 17 species, 9 *CARNIVORA* (*Carnivore*) species, and 1 *ARTIODACTYLA* (*hoofed)* specie.

Of reptiles represented with 25 species in the National Park and ecological boundaries, there are European Pond Turtle and Striped-neck Terrapin populations, though not very large, which are scattered in water system and along coastal areas.

Image 3. Heron Seen in Lake Gala Natural Habitat

Recreational opportunities

Lake Gala has a versatile habitat as it has fresh water resources and wetlands, is close to the sea, has a forest ecosystem in close proximity, meadows, and highlands. The National Park is also located in the north-south migration route of birds in Turkey so it is suitable for bird watching, habitat observation, and nature photography activities. On 15.05.2013, Uzun Develi Development Plan was approved to regulate land development decisions in order to establish a proper preservation–usage balance for the Lake Gala National Park in order to pass it on to future generations as a national heritage. The plan provides for visitor attractions such as a 12km natural walking track, bicycle track, bird watching tower, scenic viewpoints, introduction centre in the Park.

2. **According to water quality analyses:**

According to results obtained:

Around Lake Gala, there are plant production and animal breeding activities, i.e. rice fields, and cattle breeding in pastures. Lake's water is a valuable resource for meeting drinking water needs of animals.

Image 4. Rice production next to Lake Gala

Due to intensive agricultural activities carried out around Lake Gala, the Lake is exposed to significant levels of organic and inorganic contamination resulting from flow of some of tail water from paddy fields in İpsala and Keşan regions, and flow of some of Ergene River's water into the Lake.

As great amounts of chemical composite fertilizers (20-20-0, 18-46-0) are used for rice production around the Lake, the available phosphorus quantity has reached high levels (11,48 mg kg^{-1}-97,36 mg kg^{-1}). Though the phosphorus is washed out of the soil slowly, use of water-soluble fertilizers will enable washing to a certain extent in paddy cultivation where water in the paddy field is circulated continuously.

As paddy cultivation fields are under water most of the year, there are high quantities of available iron and manganese as plant nutrients in the close proximity of lake (0-15 km diameter) (e;15,08 mg kg^{-1}-174,34 mg kg^{-1}, Mn;39,48 mg kg^{-1}-101,84 mg kg^{-1}) (Gürbüz et al.,2018). Quantity of elements in Lake water reaches to high values in some months due to surface and underground feeding, as well as flow of sediments from surrounding areas.

Image 5. Animal Breeding Activities around the Lake

Existence of high quantities of lead (pb) in the Lake water in some months is assumed to be caused by use of agricultural equipments during paddy cultivation, and traffic in the highways in the region.

3. Other problems relating to Lake Gala, and measures required to be taken for such problems

- Though it is prohibited, harvest wastes from fields used for cultivating paddy around the Lake are illegally burnt during winter and spring which deteriorates the air quality.
- Mandatory fertilizing rules based on soil analysis should be imposed for paddy fields in the region in order to prevent use of excessive amounts fertilizers with water-soluble nitrogen and phosphorus content, optimize use of fertilizers, and reduce their impacts on the water quality. In addition, agricultural enterprises should be subject to trainings on good agricultural practices intended to prevent nitrate contamination.
- Regulations should be put into effect for farms around the Lake, and discharge of farm wastes into the Lake should be prevented.
- Efficiency of existing management plan should be improved, management and coordination activities should be in place at basin level, and water quality changes should be monitored and evaluated online in order to ensure continuity of monitoring activities in the Lake, and improve water quality of the Lake.

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